

PACER Update Status

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What is PACER?

Probabilities of Atmospheric Conditions and Environmental Risk (PACER) is a MSFC/Natural Environments Branch in-house analysis tool for computing launch availability with respect to weather and near-surface environmental conditions.

Current analyzable parameters:

- Temperature (TM)
- Lightning distance (LTGR)
- Mean wind speed/direction (MWS, MWD)
- Peak wind speed/direction (PWS, PWD)
- Precipitation (PRCP)
- Thunderstorms (TSTM)
- Significant wave height (SWH)
- Wave period (PRD)
- Oceanic 10-m wind speed (SPD)
- Visibility (VIS)
- Cloud ceiling (CCL)



PACER Components

1. Datasets: Coincident time series of climatology data in PACER-specific format
2. GUI: Graphical User Interface used for defining/selecting scenarios and running analyses
3. Engine: Computational code used to determine GO/NOGO intervals and compute probabilities

PACER Outputs

Given a set of user-defined, vehicle-specific environmental constraints, PACER computes the probability of satisfying all constraints (GO) by month and hour of the day.

| Hour (UTC) | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Ann |
|------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0 | 77.7 | 75.2 | 80.3 | 88.6 | 85.8 | 83.9 | 89.6 | 86.6 | 84.6 | 82.7 | 77.6 | 75.8 | 82.4 |
| 1 | 78.5 | 77.0 | 83.8 | 87.0 | 88.6 | 86.4 | 90.7 | 90.2 | 86.7 | 82.1 | 80.5 | 75.2 | 83.9 |
| 2 | 76.5 | 74.6 | 85.2 | 89.0 | 89.5 | 86.1 | 93.8 | 90.7 | 86.1 | 83.5 | 79.6 | 72.8 | 84.0 |
| 3 | 75.6 | 73.9 | 83.8 | 88.8 | 90.8 | 91.0 | 96.2 | 94.2 | 90.2 | 84.4 | 79.4 | 71.4 | 84.9 |
| 4 | 75.7 | 76.9 | 82.0 | 89.7 | 92.6 | 92.6 | 96.2 | 94.2 | 89.9 | 86.0 | 78.3 | 72.4 | 85.5 |
| 5 | 73.2 | 76.9 | 79.6 | 89.7 | 90.3 | 94.0 | 96.7 | 96.5 | 91.1 | 83.7 | 77.7 | 71.5 | 85.0 |
| 6 | 69.7 | 74.9 | 81.0 | 89.6 | 90.2 | 94.1 | 97.0 | 95.3 | 93.7 | 84.5 | 75.8 | 68.4 | 84.5 |
| 7 | 70.7 | 72.0 | 81.6 | 86.8 | 89.5 | 94.0 | 95.7 | 96.2 | 92.7 | 83.8 | 73.5 | 68.4 | 83.8 |
| 8 | 68.7 | 72.1 | 79.5 | 86.4 | 89.6 | 92.0 | 95.9 | 96.7 | 93.8 | 84.0 | 73.8 | 66.8 | 83.0 |
| 9 | 66.2 | 67.6 | 78.1 | 85.3 | 88.7 | 90.7 | 94.9 | 96.1 | 91.7 | 81.8 | 73.2 | 68.1 | 81.8 |
| 10 | 65.6 | 68.5 | 76.6 | 80.6 | 86.1 | 86.1 | 93.1 | 96.3 | 88.3 | 80.2 | 72.2 | 64.5 | 79.9 |
| 11 | 60.8 | 62.4 | 74.1 | 77.9 | 80.3 | 81.6 | 90.2 | 90.7 | 84.2 | 75.3 | 70.2 | 62.2 | 75.8 |
| 12 | 59.6 | 59.5 | 69.2 | 78.6 | 84.7 | 84.9 | 90.5 | 91.4 | 84.8 | 72.6 | 65.1 | 56.8 | 74.8 |
| 13 | 58.8 | 61.1 | 74.3 | 80.9 | 88.9 | 87.8 | 91.8 | 93.6 | 86.3 | 77.2 | 69.1 | 58.1 | 77.3 |
| 14 | 66.7 | 66.7 | 74.8 | 81.1 | 84.5 | 86.5 | 93.0 | 94.4 | 86.0 | 79.6 | 71.1 | 66.4 | 79.2 |
| 15 | 70.9 | 68.2 | 73.3 | 81.7 | 85.9 | 83.7 | 92.7 | 93.2 | 83.9 | 78.6 | 71.2 | 70.6 | 79.5 |
| 16 | 72.9 | 68.7 | 76.1 | 79.5 | 84.3 | 80.7 | 90.0 | 87.7 | 82.5 | 80.8 | 72.3 | 69.4 | 78.8 |
| 17 | 71.8 | 69.0 | 76.7 | 79.4 | 86.3 | 79.2 | 86.5 | 84.1 | 81.2 | 78.0 | 72.4 | 70.5 | 78.0 |
| 18 | 72.3 | 73.9 | 79.7 | 81.6 | 86.6 | 76.1 | 83.4 | 80.6 | 80.8 | 78.6 | 72.4 | 70.0 | 78.0 |
| 19 | 73.2 | 72.6 | 77.5 | 83.5 | 86.1 | 73.5 | 81.3 | 78.5 | 80.6 | 78.0 | 73.4 | 70.3 | 77.4 |
| 20 | 72.8 | 72.1 | 78.9 | 84.9 | 85.8 | 70.6 | 79.6 | 78.8 | 79.6 | 78.5 | 73.7 | 69.4 | 77.1 |
| 21 | 74.0 | 72.4 | 77.2 | 84.4 | 86.4 | 75.7 | 79.4 | 81.6 | 80.7 | 78.1 | 74.1 | 69.5 | 77.8 |
| 22 | 75.5 | 73.9 | 79.2 | 86.6 | 87.0 | 79.4 | 81.9 | 84.0 | 81.7 | 78.4 | 74.4 | 71.6 | 79.5 |
| 23 | 75.0 | 74.1 | 81.4 | 85.4 | 89.5 | 80.8 | 84.5 | 83.5 | 82.2 | 80.8 | 75.5 | 73.4 | 80.5 |
| Net month | 70.9 | 71.0 | 78.5 | 84.5 | 87.4 | 84.7 | 90.2 | 89.8 | 85.9 | 80.5 | 74.0 | 68.9 | 80.5 |

Update Motivation

- Originally, PACER used Shuttle Landing Facility (SLF) hourly reports and old 60-ft pad tower data, which are no longer available
- Other data sources have been superseded or require updating the period of record (POR)
- New capabilities were desired (wind placards evaluated at multiple heights)
- Sea state analysis is being decoupled from PACER due to statistical independence, to be performed by a separate tool
- Requested updates to support ESD-7B, Artemis II Launch Probability Technical Performance Measure (TPM) quarterly update schedule

Update Process

1. Replace/update data sources
2. Modify GUI to account for new data and new capabilities
3. Update computational engine to analyze new scenario definitions
4. Test

Dataset Updates

| Parameter | Old source | Old POR | New Source | New POR |
|---------------------------------|---------------|------------------|-----------------|------------------|
| Nearest lightning distance | NLDN archive | 1/1988 - 12/2012 | NLDN archive | 1/1990 - 12/2020 |
| Temperature | Old pad tower | 1/1995 - 12/2007 | Tower 313 | 1/1995 - 12/2019 |
| RH | Old pad tower | 1/1995 - 12/2007 | Tower 313 | 1/1995 - 12/2019 |
| Peak wind speed | Old pad tower | 1/1995 - 12/2007 | Tower 313 | 1/1995 - 12/2019 |
| Peak wind direction | Old pad tower | 1/1995 - 12/2007 | Tower 313 | 1/1995 - 12/2019 |
| Precipitation | SLF reports | 3/1978 - 4/2007 | KSC Rain Gauges | 1/1999 - 2/2019 |
| Thunderstorms | SLF reports | 3/1978 - 4/2007 | * | |
| Cloud ceiling | SLF reports | 3/1978 - 4/2007 | ** | |
| Visibility | SLF reports | 3/1978 - 4/2007 | ** | |
| Significan wave height | ERA1 | 1/1979 - 12/2018 | *** | |
| Wave period | ERA1 | 1/1979 - 12/2018 | *** | |
| Near-surface oceanic wind speed | ERA1 | 1/1979 - 12/2018 | *** | |
| | | 1/1995 - 4/2007 | 1/1999 - 2/2019 | |

| |
|----------------------------------|
| Extended POR |
| Changed source, extended POR |
| Constraint no longer implemented |

| |
|---------------------------------------|
| * Covered by LTGR, PRCP constraints |
| ** No longer range safety constraints |
| *** Sea state analysis decoupled |

GUI Updates

Low temperature constraint based on MWS and RH

Dual unit system inputs with automatic conversions

New Executive options

Supports directional placards

Wind evaluations at multiple heights

The GUI interface is divided into several sections:

- Executive Controls:** Includes buttons for Run, Load CFG, Save CFG, and Exit. There are checkboxes for "Save vector outputs" and "Select Filename".
- Low Temperature Controls:** Includes radio buttons for "No constraint", "Set thresholds", and "Use table".
- High Temperature Controls:** Includes radio buttons for "No constraint", "Set thresholds", and "Use placard". It also has checkboxes for "54 ft height" and "204 ft height" with dual unit inputs (C or F).
- Lightning Distance Controls:** Includes radio buttons for "No constraint" and "Set threshold". It has dual unit inputs for "18.5 km, or 10.0 nmi".
- Mean Wind Controls:** Includes radio buttons for "No constraint", "Set thresholds", and "Use placard". It features a directional placard plot and a "Display units" section with "m/s" and "kts" options.
- Peak Wind Controls:** Includes radio buttons for "No constraint", "Set thresholds", and "Use placard". It has checkboxes for "54 ft height" and "204 ft height" with dual unit inputs (m/s or kts).
- Precipitation Controls:** Includes radio buttons for "No constraint" and "Select Gauges". It features a map showing rain gauge locations (RG 08, RG 09, RG 12, RG 14, RG 15) and a label "LC 39B".

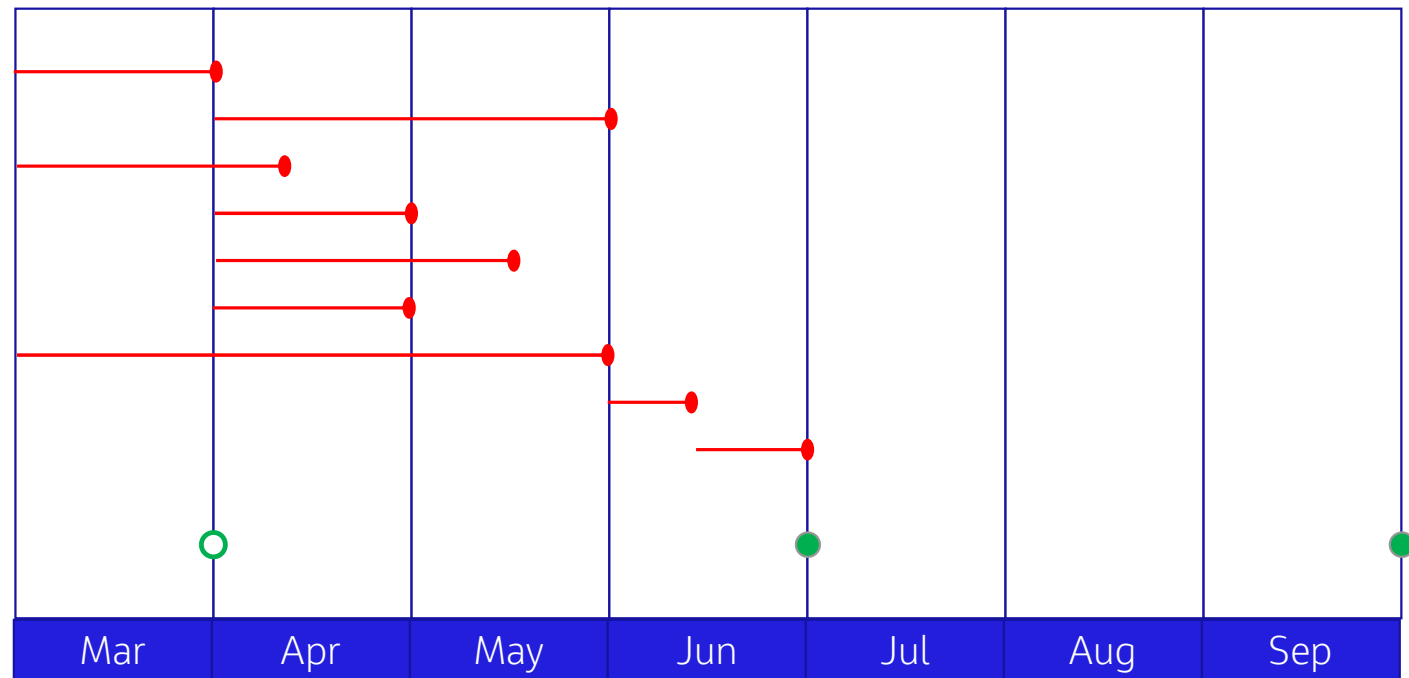
Individual rain gauge selection with location display

Computational Engine Updates

- Primarily scavenging and repurposing old code
- Writing some custom code to account for new capabilities and new source data
- Integrating and packaging

Proposed Update Schedule

- Executive controls
- “Run” functionality
- Precipitation controls
- RH data
- Wind data
- Temperature data
- Engine functionality
- Alpha testing
- Independent testing
- TPM outputs



Questions

